TRANSMITTAL OF APPEAL BRIEF (Large Entity)

Docket No.
89190.072901

In Re Application Of: **Keegan, et al.**

Application No.	Filing Date	Examiner	Customer No.	Group Art Unit	Confirmation No.
10/032,606	10/19/01	R. Alejandro	23469	1745	8160

Invention: **FUEL CELL HAVING OPTIMIZED PATTERN OF ELECTRIC RESISTANCE**

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Dennis Danella

Signature

Dated: **October 27, 2004**

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CERTIFICATE OF MAILING BY FIRST CLASS MAIL (37 CFR 1.8) Applicant(s): **Keegan, et al.**			Docket No. **89190.072901/DP-304631**	
Application No. **10/032,606**	Filing Date **October 19, 2001**	Examiner **R. Alejandro**	Customer No. **23469**	Group Art Unit **1745**

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is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on **October 27, 2004**
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IN THE UNITED STATES PATENT & TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant(s): Keegan et al.	)	Examiner: R. Alejandro
Serial No.: 10/032,606	)	Art Unit: 1745
Filed: October 19, 2001	)	
For: FUEL CELL HAVING OPTIMIZED PATTERN OF ELECTRIC RESISTANCE	)	

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is an appeal from the final rejection of the Examiner dated April 13, 2004 rejecting claim 2.

The Commissioner is hereby authorized to charge the fee of $340.00 required under 37 C.F.R. § 41.20(b)(2), and any other fee which may be due, or credit any overpayment, to Deposit Account No. 10-0223. Further, if necessary, please consider this submission as a petition for an extension of time and charge any necessary fees that may be due to the Deposit Account listed above.

TABLE OF CONTENTS

I. REAL PARTY IN INTEREST

The subject application is owned by Delphi Technologies, Inc. of P.O. Box 5052, Troy, Michigan 48007-5052.

II. RELATED APPEALS AND INTERFERENCES

There are no known related appeals or interferences which would have any bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 2 has been rejected and is subject to this appeal;

Claims 3-15 have been withdrawn from this application; and

Claims 1 and 16 were cancelled from the patent application.

IV. STATUS OF AMENDMENTS

In response to the Final Office Action dated April 13, 2004, Applicants submitted a First Amendment and Response ("the First Amendment") dated June 16, 2004 where claims 1 and 16 were cancelled and claim 2 was rewritten to incorporate the limitations of claim 1. The First Amendment was not entered by the Examiner because the word "areally" was inadvertently included in Subsection C of claim 2.

Applicants submitted a Second Amendment and Response ("the Second Amendment") dated July 19, 2004 where claims 1 and 16 were cancelled and claim 2 was rewritten to incorporate the limitations of claim 1. The Second

Amendment was entered by the Examiner for purposes of the present Appeal. *See Advisory Action* dated August 11, 2004.

V. SUMMARY OF CLAIMED SUBJECT MATTER

In general, a fuel cell may be used to generate electric current by controllably combining elemental hydrogen and oxygen. *See Specification*, pg. 1, lines 8-9. In particular, such a fuel cell may include an anodic layer and a cathodic layer separated by an electrolyte formed of a ceramic solid oxide. *See id.* at pg. 1, lines 9-10. Either pure hydrogen or reformate is flowed along the outer surface of the anode and diffuses into the anode. *See id.* at pg. 1, lines 11-13. Oxygen, typically from air, is flowed along the outer surface of the cathode and diffuses into the cathode. *See id.* at pg. 1, lines 13-14. Each O_2 molecule is split and reduced to two O^{-2} ions at the cathode/electrolyte interface. *See id.* at pg. 1, lines 14-15. The oxygen ions diffuse through the electrolyte and combine at the anode/electrolyte interface with hydrogen ions to form molecules of water. *See id.* at pg. 1, lines 15-17. The anode and cathode are connected externally through a load to complete a circuit and general electric current. *See id.* at pg. 1, lines 17-18; pg. 2, line 1. This type of fuel cell is known in the art as a "solid oxide fuel cell" (SOFC). *See id.* at pg. 1, line 11.

A single fuel cell is capable of generating a relatively small voltage and wattage. *See id.* at pg. 2, line 3. Therefore, it is usual to stack together a plurality of fuel cells in electrical series. *See id.* at pg. 2, lines 4-5. A typical fuel

cell stack (10) is illustrated in Fig. 1 of the present patent application showing two fuel cells (A, B) connected in series. *See id.* at 7, lines 8-12.

As best seen in FIG. 1, each anode (16) and cathode (18) is in direct chemical contact with its respective surface of the electrolyte (14), and each anode (16) and cathode (18) has a respective free surface (20, 22) forming one wall of a respective passageway (24, 26) for flow of gas across the surface. *See id.* at pg. 7, lines 15-18. In prior art fuel stack (10) shown in FIG. 1, anode (16) of fuel cell (B) faces and is electrically connected to an interconnect (28) by filaments (30) extending across but not blocking passageway (24). *See id.* at pg. 7, lines 18-20. Similarly, cathode (18) of fuel cell (A) faces and is electrically connected to interconnect (28) by filaments (30) extending across but not blocking passageway (26). *See id.* at pg. 7, lines 20-21.

The present invention relates to preventing the buildup of unacceptably high O^{-2} ion concentrations and to promote additional consumption of hydrogen by areally varying or grading the electrical resistance of the cell. *See id.* at pg. 11, lines 6-10. In particular, in accordance with the invention, by areally varying or grading the electrical resistance, a non-uniform electrical resistivity over the flow area of the cell is accomplished. *See id.* at pg. 3, lines 17-18.

Resistance is higher in areas of the cell having locally low levels of hydrogen than in areas having locally high levels of hydrogen. *See id.* at pg. 3, lines 18-20. Since the rate of oxygen ion migration through the electrolyte is inversely proportional to the resistance of the circuit at any give point in the cell, the areal pattern of resistance is shaped in inverse proportion to the steady-state

hydrogen concentration. *See id.* at pg. 3, lines 20-22; pg. 4, line 1. Excess oxygen ion migration and buildup is selectively suppressed in regions having low hydrogen concentration and is correspondingly increased in regions having a surfeit of hydrogen. *See id.* at pg. 4, lines 1-3. Thus, destructive oxidation of the anode is prevented and a greater percentage of the hydrogen passed into the cell is consumed, thereby increasing electric output. *See id.* at pg. 4, lines 3-5.

The following embodiments were the subject of one or more of claims 3-15, which were withdrawn from the present patent application due to a restriction requirement dated May 20, 2003. However, Applicants believe that the following embodiments are representative of the invention set forth in claim 2.

In a first embodiment of the present invention, the chemical composition of either the cathode or the anode itself is selectively varied regionally to increase or decrease local conductivity. *See id.* at pg. 11, lines 11-12. The cathode comprises, for example, a chemical composition of lanthanum strontium manganate of lanthanum strontium iron. *See id.* at pg. 11, lines 12-14. In the embodiment, the atomic proportion of lanthanum to strontium in the composition is varied across the cathode non-uniformly so that the atomic proportion is increased in regions of the cathode where high concentrations of hydrogen are found to exist. *See id.* at pg. 11, lines 14-17. For example, in areas of high hydrogen concentration where greater conductivity is desired, the atomic proportion of lathanum to strontium may by 80% to 20%, respectively, while in areas of low concentration, the proportion would be reversed. *See id.* at pg. 11, lines 17-20. The chemical composition of the anode can also be selectively

varied. *See id.* at pg. 11, line 20. The anode comprises a mixture of a conductive material, for example, nickel, and a dielectric material, for example YSZ. *See id.* at pg. 11, lines 20-22. The nickel percentage is varied non-uniformly to provide more nickel, and hence greater conductivity, in regions of high hydrogen concentration and less nickel, and hence lesser conductivity, in hydrogen-poor regions. *See id.* at pg. 11, line 22; pg. 12, lines 1-2.

As best seen in FIG. 7, a second embodiment (50) is shown wherein the porosity of the cathode can be selectively varied so as to affect the permeability of the oxygen through the cathode. *See id.* at pg. 12, lines 3-4. In regions of high hydrogen concentration, the cathode is made more porous (52) so that more oxygen passes therethrough; in regions of low hydrogen concentration the cathode is made less porous (54) so that less oxygen passes therethrough. *See id.* at pg. 12, lines 4-7.

In a third embodiment (55), referring to FIG. 8, the spatial density of conductive filaments (30) extending through reformate flow space (24) between the surface (20) of anode (16) and anode current collector (34) is selectively varied in direct proportion to the hydrogen concentration pattern in the cell. *See id.* at pg. 12, lines 8-11. In the example shown, filaments (30) are less numerous and spaced farther apart in the direction of reformate flow from the entrance (25) to the exit (29). *See id.* at pg. 12, lines 11-13.

As best seen in FIG. 9, a fourth embodiment (60) is shown wherein the interconnects (28) or current collectors (32, 34) are selectively embossed in a pattern of protrusions (56) which extend above the planar surface of the element

to provide an areal pattern of conductive contact points with an anode or cathode, resulting in a resistance gradient in accordance with the invention by providing an inverse conductivity gradient. *See id.* at pg. 12, lines 16-20.

In a fifth embodiment (65), referring to FIG. 10, the free surface, shown as anode surface (20), of any electrical element forming a gas flow space bridged by filaments (anode, cathode, interconnect, or current collector) is partially covered with dielectric material to selectively provide an areal pattern of non-conductivity (high resistance) regions (52) in which filaments are unable to make electrical contact, resulting in a resistance gradient between the areas of high hydrogen concentration and the areas of low hydrogen concentration. *See id.* at pg. 12, lines 21-22; pg. 13, lines 1-5. The net effect is to disable a pattern of filaments in regions of low hydrogen concentration, which is functionally the same as spacing active filaments farther apart, as shown in third embodiment (48). *See id.* at pg. 13, lines 7-9.

In a sixth embodiment (70, 70') of a fuel cell in accordance with the invention, referring to FIGS. 11a. and 11b., the cathode surface (22) or the corresponding interconnect or current collector surface (32) is partially covered with a wedge (46) of dielectric material, the areal extent and thickness of layer (46) being selectively graded to provide a resistance gradient between the areas of high hydrogen concentration and the areas of low hydrogen concentration. *See id.* at pg. 13, lines 10-15. The wedge thickness shown in FIGS. 11a. and 11b. is greatly exaggerated for clarity of presentation. *See id.* at pg. 13, lines 15-16. In actuality, the thickness need be from one to only a few atoms of an easily

applied and controlled dielectric material, for example, YSZ or other glass. *See id.* at pg. 13, lines 16-18. Of course, the wedge may be applied with equal effect to any conductive element anywhere in stack (70"), for example, as shown in FIG 11c, to the free surface of either anode (20) (shown), interconnect (28), or the anode current collector (34). *See id.* at pg. 13, lines 20-21; pg. 14, lines 1-2.

Typically, the thickness of the electrolyte element is approximately 1 micron. *See id.* at pg. 14, lines 3-4. In a seventh embodiment, the thickness of the electrolyte element is selectively varied regionally to increase or decrease local conductivity. *See id.* at pg. 14, lines 3-5. Where areas of low hydrogen concentration exists, the electrolyte is made thicker to decrease conductivity, and vice versa. *See id.* at pg. 14, lines 5-6.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claim 2 stands rejected under 35 U.S.C. § 102(e) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over U.S. Publication No. 2002/0098400 to Mieney et al., which issued as U.S. Patent No. 6,680,136.

VII. ARGUMENT

Issue 1 – Whether claim 2 is anticipated under 35 U.S.C. § 102(e), or in the alternative, obvious under 35 U.S.C. § 103(a) by U.S. Publication No. 2002/0098400 to Mieney et al.

Independent claim 2 is directed to a fuel cell for generating an electric current by combining hydrogen and oxygen wherein resistance to the flow of electric current through the cell is non-uniform over a flow area of the cell to regulate the flow of oxygen ions through any region of the cell in proportion to the

partial pressure of hydrogen in the region. The fuel cell further includes an anode, a cathode and a solid oxide electrolyte separating the anode from the cathode. The anode is used to react the hydrogen ions with the oxygen ions, wherein the hydrogen ions are derived from gaseous molecular hydrogen flowing in a first flow path through a first portion of the cell. The cathode provides the oxygen ions derived from gaseous molecular oxygen flowing in a second flow path through a second portion of the cell. Further, the electrical resistance is non-uniform over one of the anode, cathode, and electrolyte.

By selectively varying the uniformity of the electrical resistance across one of the anode, cathoe and electrolyte of a fuel cell in accordance with the present invention, numerous advantages are realized. For example, the non-uniform electrical resistance over the flow area of one of the anode, cathode, and electrolyte suppresses excess oxygen migration and build-up in regions having low hydrogen concentration and correspondingly increases oxygen migration and build-up in regions having a surfeit of hydrogen. *See Specification*, pg, 4, lines 1-3. As a result, destructive oxidation of the fuel cell is prevented and electrical output is increased due to a greater percentage of hydrogen consumption. *See Specification*, pg, 4, lines 3-5.

Appellants submit that the Mieney reference does not teach or suggest a fuel cell wherein <u>the electrical resistance is non-uniform over one of the anode, cathode, and electrolyte</u> as recited in claim 2. In the Final Office Action, claim 2 appears to have been rejected for three reasons. First, the Examiner stated that "each fuel cell component presents a varied appearance of electrical resistance

pattern due to its material composition." *Final Office Action*, pg. 8, lines 8-10; pg. 11, lines 14-15. In particular, the Examiner stated that the construction material of each of the fuel cell components (i.e., anode, cathode, electrolyte) differ from one another, therefore the electrical resistance will be non-uniform due to the change in materials as the electrical current flows through the anode, cathode and electrolyte. *See id.* at pg. 8, lines 5-8.

While the electrical resistance may vary as the electrical current flows through the entire fuel cell (i.e., through the layered anode, cathode <u>and</u> electrolyte), there is nothing in the Mieney reference that teaches or suggest providing <u>one of</u> the anode (30), cathode (50), and electrolyte (40) with non-uniform electrical resistance. The fact that each of the materials may have different electrical resistance characteristics relative to each other due to their material composition does not mean that the electrical resistance of each component, <u>taken alone</u>, is non-uniform. The Mieney reference does not in any way teach or suggest that: 1) the electrical resistance of the anode is non-uniform; 2) the electrical resistance of the cathode is non-uniform; or 3) the electrical resistance of the electrolyte is non-uniform. As such, Appellants respectfully request that the Examiner's first reason for rejecting claim 2 be withdrawn.

Second, claim 2 was rejected because the non-uniform electrical resistance over one of the anode, cathode, and electrode is inherently disclosed in the Mieney reference. *See Final Office Action*, pg. 11, lines 7-15. The Examiner based the inherency rejection on the following proposition: "the

electrical resistance of any body is intrinsically related to the chemical nature of its construction material." *See Final Office Action*, pg. 11, lines 9-11; *Advisory Action*, pg. 2, lines 12-13. Therefore, the Examiner concludes that "the prior art fuel cell components seem to be identical except that the prior art is silent as to an inherent function property and/or characteristic . . . and that it would be so recognized by persons of ordinary skill." *See Final Office Action*, pg. 12, lines 16-19.

Appellants do not dispute that the electrical resistance of any body is intrinsically related to the chemical nature of its construction material. Nevertheless, the Examiner has not met his burden of showing that non-uniform electrical resistance over one of the anode, cathode and electrolyte is inherently disclosed in the Mieney reference.

Just because each of the fuel cell components (i.e., anode, cathode and electrolyte) are included in claim 2 are present the Mieney reference, does not suggest that the properties of the fuel cell are inherently disclosed in the Mieney reference. Claim 2 is in part defined by a property of the fuel cell, wherein the electrical resistance of one of the anode, cathode, and electrolyte is non-uniform. *See E.I. DuPont & Co. v. Phillips Petroleum Co.*, 849 F.2d 1430, 1435, 7 USPQ.2d 1129 (Fed. Cir. 1988) (stating that the invention may be defined in part by property limitations). In order "[t]o establish inherency, the extrinsic evidence 'must make clear that the missing [fuel cell property] is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill.'" *In re Robertson*, 169 F.3d 743, 745, 49 USPQ.2d 1949, 1950-

51 (Fed. Cir. 1999) (citing *Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 USPQ.2d 1746, 1749 (Fed. Cir. 1991)). Further, a limitation is inherent if it is the "natural result flowing from" the explicit disclosure of the prior art. *Schering Corp. v. Geneva Pharm.*, 339 F.3d 1373, 1379 (Fed. Cir. 2003).

The Examiner has not specifically identified any portion of the Mieney reference that clearly indicates that the resistance to the flow of electric current through one of the anode, cathode, and electrolyte is non-uniform. *See Ex parte Schricker*, 56 USPQ.2d 1723, 1725 (B.P.A.I. 2000) (unpublished) (stating that the Examiner should point to the page and line of the prior art to justify a rejection based on inherency). While the Mieney reference may include the same general fuel cell components, there is nothing to indicate that excess oxygen migration and buildup is suppressed in regions having low hydrogen concentration and increases in regions having a surfeit of hydrogen to reduce corrosion in the fuel cell. *See Specification*, pg. 4, lines 1-3. Providing one of the anode, cathode and electrolyte with the property of non-uniform electrical resistance in claim 2 allows for a reduction in corrosion, which is not in any way taught or suggested in the Mieney reference. Furthermore, there is no indication that reduced fuel cell corrosion is a natural result flowing from the anode, cathode and electrolyte used in the Mieney reference. *See Schering*, 339 F.3d at 1379; *see also Robertson*, 169 F.3d at 745, 49 USPQ.2d at 1951 (stating that the mere fact that a certain thing may result from a set of circumstances in not sufficient to establish inherency).

The third reason for rejecting claim 2 appears to have been based upon Page 3, lines 17-22 of the Specification of the present invention. *See Final Office Action*, pg. 8, lines 10-13; pg. 11, lines 15-16; pg. 12, lines 1-3. In particular, the Examiner stated that the electrical resistance is non-uniform over one of the anode, cathode and electrolyte because the electrical resistance is inherently higher in areas of the cell having locally low levels of hydrogen than in areas having locally high levels of hydrogen. *See id.* at pg. 8, lines 10-12. Therefore, the electrical resistance of the fuel cell component (e.g., the anode) at the inlet will be lower due to a high concentration of hydrogen, and lower at the outlet due to a lower concentration of hydrogen. *See id.* at pg. 8, lines 13-17.

The Examiner's reliance on the Specification of the present patent application is misplaced. The portion of the Specification located on Page 3, lines 17-22 is a summary of the present invention, not an admission of prior art or inherent function of the fuel cell. The present invention as set forth in claim 2 states that the electrical resistance is non-uniform in <u>one of</u> the anode, cathode and electrolyte. The non-uniform electrical resistance over one of the fuel cell components is highlighted in the summary of the invention, which states that the "[r]esistance is higher in areas of the cell having locally low levels of hydrogen than in areas having locally high levels of hydrogen." *Specification*, pg. 3, lines 18-20.

The electrical resistance of a fuel cell component (e.g., the anode) is not inherently non-uniform merely because of the hydrogen concentration at a local fuel cell point, as suggested by the Examiner. *See Final Office Action*, pg. 8, line

21; pg. 12, lines 10-11. If this were the case, conventional fuel cells would not suffer from corrosion, which commonly occurs due to partial pressure buildup of O^{-2}. *See Specification*, pg. 3, lines 1-8. The purpose of the present invention is to cause the electrical resistance of <u>one of</u> the anode, cathode and electrolyte non-uniform so that excess oxygen migration and buildup is selectively suppressed in regions having low hydrogen concentration and increases in regions having a surfeit of hydrogen. *See Specification*, pg. 4, lines 1-3. The Mieney reference does not teach or suggest a fuel cell having an anode, cathode and electrolyte with non-uniform electrical resistance.

Moreover, the Mieney reference does not teach or suggest a fuel cell wherein the <u>resistance to the flow of electric current through the cell is non-uniform over a flow area of the cell to regulate the flow of oxygen ions through any region of the cell in proportion to the partial pressure of hydrogen in the region</u> as recited in claim 2. While the above limitation is included in the preamble of claim 2, it should be construed as a limitation in claim 2 since it is "necessary to give life, meaning, and vitality to the claim." *See Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305, 51 USPQ.2d 1161, 1165-66 (Fed. Cir. 1999) (citing *Kropa v. Robie*, 187 F.2d 150, 152, 88 USPQ 478, 480-81 (C.C.P.A. 1951)). As previously stated, the Mieney reference discloses nothing more than a fuel cell having an anode, cathode and an electrolyte. *See Mieney*, FIG. 2. There has been nothing to indicate that the resistance to the flow of electric current through the fuel cell in the Mieney reference is non-uniform so

that the flow of oxygen ions is regulated in proportion to the partial pressure of hydrogen to reduce the amount of corrosion in the fuel cell.

For at least the foregoing reasons, Appellants submit that the Mieney reference fails to teach or suggest every limitation disclosed in claim 2 and requests that the rejection of claim 2 be withdrawn.

Respectfully submitted,

Dated: 10/27/04

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VIII. CLAIMS APPENDIX

The text of the claim involved in the appeal reads as follows:

2. A fuel cell for generating an electric current by combining hydrogen and oxygen wherein resistance to the flow of electric current through the cell is non-uniform over a flow area of the cell to regulate the flow of oxygen ions through any region of said cell in proportion to the partial pressure of hydrogen in said region, said fuel cell further comprising:

a) an anode for reacting hydrogen ions with said oxygen ions, said hydrogen ions being derived from gaseous molecular hydrogen flowing in a first flow path through a first portion of said cell;

b) a cathode for providing said oxygen ions derived from gaseous molecular oxygen flowing in a second flow path through a second portion of said cell; and

c) a solid oxide electrolyte separating said anode from said cathode,

wherein said electrical resistance is non-uniform over one of said anode, cathode, and electrolyte.

IX. EVIDENCE APPENDIX

There has been no additional evidence submitted, entered by the Examiner, or relied upon by the Appellant in the present appeal.

X. RELATED PROCEEDINGS APPENDIX

There have been no proceedings or decisions rendered by a court or the Board that relate to the present patent application.